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CORRESPONDENCE

## Letters to the Editor

# Renal Venous Congestion and Renal Function in Congestive Heart Failure

Jessup and Constanzo (1) recently proposed mechanisms explaining the reported inverse relationship between central venous pressure (CVP) and glomerular filtration rate (GFR) in congestive heart failure (CHF) (2,3). Their figure, depicting the impact of venous congestion, seems implausible because efferent arteriolar pressure exceeds afferent arteriolar pressure. Understanding how increased CVP relates to decreased GFR is important because both variables predict mortality (4).

If the renal vascular bed was rigid, elevated venous pressure would increase pressure all along the renal vascular tree and cause *increased* net ultrafiltration pressure. Normally, this is corrected by autoregulation (5). In a diseased kidney, with failing autoregulation, glomerular pressure could indeed increase.

Regarding the interstitial and tubular compartments, elevated renal venous pressure will increase interstitial hydrostatic pressure (Pint). If Pint exceeds tubular hydrostatic pressure, tubules will collapse. Consequently, increasing tubular hydrostatic pressure (6) will oppose filtration and decrease net ultrafiltration pressure. This mechanism is supported by experimental data showing a linear decrease in GFR upon increases in renal venous pressure, in particular during volume expansion (7). How CVP, intra-abdominal pressure, and accumulation of renal interstitial fluid and adipose tissue affect interstitial compliance and Pint is complex.

Furthermore, elevated angiotensin II constricts both afferent and efferent arterioles and decreases renal blood flow. Fortunately, and different from the view in the editorial comment (1), the renin-angiotensin system has an internal brake whereby angiotensin II inhibits renin release to prevent the positive feedback proposed by the authors.

Therefore, the contribution of renal venous congestion to low GFR in CHF is extremely complex. Note that we have neglected the tubuloglomerular feedback system, colloid osmotic pressure, and neurohormonal systems. A systematic analysis of mechanisms that contribute to decreasing GFR in CHF is warranted.

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## Reply

We greatly appreciate the letter from Dr. Joles and colleagues regarding our editorial comment (1).

We completely agree that the mechanisms in heart failure by which renal venous congestion contributes to a decrease in the glomerular filtration rate (GFR) are extremely complex and are influenced by many factors including renal autoregulation, tubuloglomerular feedback, and the renin-angiotensin-aldosterone system. The main intent of the example depicted in our figure is to underscore to clinicians that in heart failure, worsening renal function is not always due to volume contraction. In fact, in the majority of patients with heart failure, a decreased GFR is due to increased congestion. Unfortunately, the elegant studies of Winton (2) and Firth et al. (3) have largely been ignored until recent analyses showed that both renal dysfunction and congestion independently predict poor outcomes in heart failure patients (4,5).

To stress the effects of increased central venous pressure on GFR, we simplified the example shown in our editorial with the assumption that the forces opposing filtration, hydrostatic pressure in the Bowman's capsule and oncotic pressure in the glomerular capillaries, remain constant. In a normal patient, net filtration pressure will be approximately 14 mm Hg:

$$[\{BP\}60 - (\{P_{BC}\}15 + \{\pi_{GC}\}21)] - [\{RAP\}58 - (\{P_{BC}\}15 + \{\pi_{GC}\}33)]$$

In patients with heart failure, assuming there is a small decrease in systemic arterial pressure from a decreased cardiac output and a small increase in central venous pressure, subtraction of the *same* forces opposing filtration from the arterial and venous sides of the circulation will result in a decrease in net filtration pressure:

$$[\{BP\}55 - (15\{P_{BC}\} + \{\pi_{GC}\}21)] - [\{RAP\}63 - (\{P_{BC}\}15 + \{\pi_{GC}\}33)] = 4 \text{ mm Hg}$$

We agree that understanding how an increase in central venous pressure affects a decrease in GFR is important because of the impact of both variables on outcomes in patients with heart failure. The complexity of the relationship between volume overload and renal function in heart failure emphasizes to us the critical importance of a close collaboration between cardiologists and nephrologists to thoroughly evaluate how increased cardiac filling pressures alter renal pathophysiology.

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# Carotid Sinus Hypersensitivity: A Diagnostic Pearl

Syncope is the sixth most common cause of hospitalization in patients older than 65 years (1). As noted by Benditt and Nguyen (2), an accurate diagnosis is the first step when considering treatment options. Of the broad differential diagnosis for syncope, carotid sinus hypersensitivity is often overlooked and is frequently underdiagnosed, although it causes syncope in a significant number of elderly individuals (2,3). The diagnosis of carotid sinus hypersensitivity rests on documenting at least 3 s of asystole (cardioinhibitory type) or a systolic pressure decrease >50 mm Hg (vasodepressor type) during carotid massage (3). Carotid sinus hypersensitivity is often excluded on the basis of a negative response to carotid massage in the supine position (3). However, it should be noted that in a significant proportion of individuals, carotid sinus hypersensitivity is only evident in the upright position. In one study, 68% of patients had documented carotid sinus hypersensitivity, 8.7% in the supine position and 60% in the 60° upright position, increasing the diagnostic yield by 52% and increasing the diagnostic accuracy from 31% in the supine position to 69% in the upright position (4). The positive predictive value increased from 77% to 96% with a specificity of 93% (4). In another study, more than one-half of the positive responses would have been missed if carotid sinus stimulation was not repeated during the head-up tilt (5). In an additional prospective, controlled cohort study of 1,149 subjects presenting with unexplained syncope and drop attacks, 19% had carotid sinus hypersensitivity and 31% of these had a positive response only with head-up tilt, giving the upright positive test 100% specificity and sensitivity (3). The investigators of that study concluded that "the diagnosis of carotid sinus hypersensitivity amenable to treatment by pacing may be missed in one-third of cases if only supine massage is performed" (3). These findings were reinforced in a more recent study in which 59% of subjects had an initial positive response to carotid massage in the upright position (6). Therefore, in testing for carotid sinus hypersensitivity, carotid sinus massage should be performed in the supine and, if negative, in the upright positions. Obtaining an accurate diagnosis of carotid sinus hypersensitivity by these simple maneuvers may decrease the need for invasive and expensive diagnostic investigations for syncope.

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## Reply

We appreciate the opportunity to respond to the letter regarding our paper (1). Dr. Kapoor, in taking note of our recent communication related to therapy of syncope (1), principally addresses a diagnostic issue related to identifying carotid sinus hypersensitivity (CSH). In essence, he highlights the importance of undertaking carotid sinus massage (CSM) with the patient in an upright posture if CSM in the supine patient is nondiagnostic. We agree with this advice. However, several points merit consideration. First, the "pearl" is not new, although perhaps worthy of repetition